

IN THE CLAIMS

Please amend the claims as follows.

1. (Previously Presented) A paint system comprising a paint supply station, a paint supply channel downstream of the paint supply station, the paint supply channel having a number of supply nodes, a paint return channel upstream of the paint supply station, the paint return channel having a number of return nodes, and a number of paint circulation lines, wherein the number of paint circulation lines includes:

a first paint circulation line including a first coupling for connecting a first paint output nozzle assembly thereto, the first paint circulation line being positioned downstream of the paint supply channel at a first supply node of the number of supply nodes, the first paint circulation line being positioned upstream of the paint return channel at a first return node of the number of return nodes, the first paint circulation line further comprising a flow induced pressure generating portion including one or more first lengths of coiled tubing for developing a first differential pressure in the first paint circulation line, the first differential pressure being proportional to the magnitude of paint flow therein, first length of coiled tubing being shaped to generate sufficient differential pressure to provide an operative first pressure differential at the first paint output nozzle assembly, and

a second paint circulation line including a second coupling for connecting a second paint output nozzle assembly thereto, the second paint circulation line being positioned downstream of the paint supply channel at a second supply node of the number of supply nodes, the second paint circulation line being positioned upstream of the paint return channel at a second return node of the number of return nodes, the second paint circulation line further comprising a second flow induced pressure generating portion including at least one second length of coiled tubing for developing a second differential pressure in the second paint circulation line, the second differential pressure being proportional to the magnitude of paint flow therein, the second length of coiled tubing being different from the first length of coiled tubing and being shaped to generate sufficient differential pressure to provide an operative second pressure differential at the second paint output nozzle assembly,

wherein each paint circulation line is substantially free of a component of sufficient size to cause accumulation of settled paint solids that cause at least one of pressure changes of a magnitude requiring system recalibration or settled solids to be deposited on a painted surface to a degree requiring remedial repair.

2. -- 3. (Cancelled)

4. (Previously Presented) A system as defined in claim 1 wherein the paint output nozzle assembly includes a paint spray gun.

5. (Original) A system as defined in claim 1 wherein the coupling is a at least one of color change valve and a manual flow through regulator with or without a quick disconnect.

6. (Previously Presented) A paint system comprising a paint supply station, a paint supply channel downstream of the paint supply station, the paint supply channel having a number of supply nodes, a paint return channel upstream of the paint supply station, the paint return channel having a number of return nodes, and a number of paint circulation lines including a first circulation line and a second circulation line,

the first circulation line including a coupling for connecting a first paint output nozzle assembly thereto, the first paint circulation line being positioned downstream of the paint supply channel at a first supply node of the number of supply nodes, the first paint circulation line being positioned upstream of the paint return channel at a first return node of the number of return nodes, the first paint circulation line further comprising a flow induced pressure generating portion including at least one first length of coiled tubing for developing a first differential pressure in the first paint circulation line, the first differential pressure being proportional to the magnitude of paint flow therein, the first length of coiled tubing being shaped to generate sufficient differential pressure to provide a first operative pressure differential at the first paint output nozzle assembly,

the second paint circulation line including a coupling for connecting a second paint output nozzle assembly thereto, the second paint circulation line being positioned downstream of

the paint supply channel at a second supply node of the number of supply nodes, the second paint circulation line being positioned upstream of the paint return channel at a second return node of the number of return nodes, the second paint circulation line further comprising a second flow induced pressure generating portion including at least one second length of coiled tubing for developing a second differential pressure in the second paint circulation line, the second differential pressure being proportional to the magnitude of paint flow therein, the second length of coiled tubing being different from the first length of coiled tubing and being shaped to generate sufficient differential pressure to provide an operative second pressure differential at the second paint output nozzle assembly, and

wherein the pressure differential of all paint circulation lines is such that the design flow rate in every paint circulation line is substantially obtained in a stable and robust fashion, wherein changes in viscosity, provided the flow stays in the laminar flow zone, will cause the design flow rates in the paint circulation lines to be substantially maintained.

7. (Previously Presented) A paint circulation system for supplying a paint mixture to a paint booth in a manufacturing operation, the paint circulation system comprising a number of paint drop lines supplying paint to a number of paint spray gun assemblies, the number of paint drop lines including a first paint drop line and a second paint drop line,

the first paint drop line including a first color change valve for connecting a first paint spray gun assembly thereto, each paint spray gun assembly being operative to spray a paint mixture received from the first paint drop line at a first operative flow rate, the first paint drop line being positioned downstream of a first paint supply node and upstream of a corresponding first paint return node, the first paint drop line further comprising a first means for generating differential pressure according to a first operative flow rate, the first means for generating differential pressure including at least one first coiled tubing that is shaped to generate the first differential pressure and is substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof, and

the second paint drop line including a second color change valve for connecting a second paint spray gun assembly thereto, the second paint spray gun assembly being operative to spray a paint mixture received from the second paint drop line at a second operative flow rate, the second paint drop line being positioned downstream of a second paint supply node and upstream of a corresponding second paint return node, the second paint drop line further comprising a second means for generating differential pressure according to a second operative flow rate, the second means for generating differential pressure including at least one second coiled tubing that is different from the first length of coiled tubing and shaped to generate the differential pressure and is substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof.

8. (Previously Presented) A paint circulation system for supplying a paint mixture to a paint booth in an automobile manufacturing operation, the paint circulation system comprising a number of paint drop lines, the number of paint drop lines including a first paint drop line and a second drop line, the first paint drop line including a first color change valve for connecting a first paint spray gun assembly thereto, the first each paint spray gun assembly being operative to spray a paint mixture received from the first paint drop line at a first operative flow rate, the first paint drop line being positioned downstream of a first paint supply node and upstream of a first paint return node, the first paint drop line further comprising a means for generating a first differential pressure according to a first operative flow rate, the means for generating the first differential pressure including at least one length of coiled tubing that is shaped to generate the first differential pressure, the first paint drop line being substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof, wherein the first paint drop line is free of pressure regulators, pressure reducing valves, pressure gauge assemblies, tees, standpipes, isolation valves, isolation diaphragms, or a combination thereof, the second paint drop line including a second color change valve for connecting a second paint spray

gun assembly thereto, the second paint spray gun assembly being operative to spray a paint mixture received from the second paint drop line at a second operative flow rate, the second paint drop line being positioned downstream of a second paint supply node and upstream of a second paint return node, the second paint drop line further comprising a means for generating a second differential pressure according to a second operative flow rate, the means for generating the second differential pressure including at least one second length of coiled tubing that is different than the first length of coiled tubing and shaped to generate the second differential pressure and is substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof, wherein the second paint drop line is free of pressure regulators, pressure reducing valves, pressure gauge assemblies, tees, standpipes, isolation valves, isolation diaphragms, or a combination thereof.

9. (Previously Presented) A paint circulation system for supplying a paint mixture to a paint booth in a manufacturing operation, the paint circulation system comprising a number of paint drop lines, each including a color change valve for connecting a paint spray gun assembly thereto, the number of paint drop lines including a first paint drop line and a second drop line, the first paint drop line including a first color change valve for connecting a first paint spray gun assembly thereto, the first paint spray gun assembly being operative to spray a paint mixture received from the first paint drop line at a first operative flow rate, the first paint drop line being positioned downstream of a first paint supply node and upstream of a first paint return node, the first paint drop line further comprising a first means for generating differential pressure according to a first operative flow rate, the first means for generating differential pressure including at least one first length of coiled tubing, wherein the first length of coiled tubing is shaped to generate the differential pressure and is substantially free of one or more sources of shear induced damage to additives contained in a paint mixture resulting in inconsistencies in a painted surface to a degree requiring remedial repair thereof, the second paint drop line including a second color change valve for connecting a second paint spray gun assembly thereto, the second paint spray gun assembly being operative to spray a paint mixture received from the

second paint drop line at a second operative flow rate, the second paint drop line being positioned downstream of a second paint supply node and upstream of a corresponding second paint return node, the second paint drop line further comprising a second means for generating differential pressure according to a second operative flow rate, the second means for generating differential pressure including at least one second length of coiled tubing which is different from the first length of coiled tubing and which is shaped to generate the second differential pressure and is substantially free of one or more sources of shear induced damage to additives contained in a paint mixture resulting in inconsistencies in a painted surface to a degree requiring remedial repair thereof.

10-12. (Cancelled)

13. (Original) A system as defined in claim 1 wherein the differential pressure in each paint circulation line is produced entirely by a combination of differential sub-pressures including a first sub-pressure produced by the flow induced pressure generating portion, a second sub-pressure produced by paint circulation line and the coupling and without a pressure regulator, or pressure reducing valve or a pressure gauge assembly or a combination thereof.

14. (Canceled)

15. (Previously Presented) A paint circulation system for a painting line, comprising:

a supply channel,

a return channel,

a plurality of drop lines downstream of the supply channel and upstream of the return channel, the plurality of drop lines including a first drop line and a second drop line,

first control means located in the first drop line for controlling a first paint flow rate, the first control means including one or more lengths of first coiled tubing shaped to adjust the first flow rate according to a first flow controlling pressure differential, and wherein the first flow controlling pressure differential is the pressure differential across the first drop line between the supply channel and the return channel,

second control means located in the second drop line for controlling a second paint flow rate, the second control means including at least one second length of coiled tubing that is different than the first length of coiled tubing and shaped to adjust the second flow rate according to a second flow controlling pressure differential, and wherein the second flow controlling pressure differential is the pressure differential across the second drop line between the supply channel and the return channel,

wherein changes to viscosity in the paint do not result in changes to the system requiring recalibration between paint drop lines.

16. (Previously Presented) A paint circulation system for a painting line, comprising:

a supply channel,

a return channel,

a plurality of drop lines downstream of the supply channel and upstream of the return channel, the plurality of drop lines including a first drop line and a second drop line,

a paint pump means for circulating paint through the supply channel, the drop lines and the return channel with a corresponding flow rate through each drop line,

wherein the first drop line includes first means for establishing a first flow controlling pressure differential between the supply channel and the return channel that is directly proportional to the first paint flow rate, the first means for establishing the first flow controlling pressure differential including one or lengths of first coiled tubing in the first drop line, wherein a change in the first flow controlling pressure differential in the first drop line causes a corresponding proportional change in the first paint flow rate through the first drop line, and

wherein the second drop line includes second means for establishing a second flow controlling pressure differential between the supply channel and the return channel that is directly proportional to a second paint flow rate flowing through the second drop line, the second means including a second length of coiled tubing that is different than the first length of coiled tubing and is shaped to establish the second flow controlling pressure differential in the second drop line, wherein a change in the second flow controlling pressure differential in the second drop line causes a corresponding proportional change in the second paint flow rate through the second drop line.

17. (Previously Presented) A paint circulation system for an automotive painting line, comprising:

a supply channel,

a return channel,

a plurality of drop lines, including a first drop line and a second drop line, downstream of the supply channel and upstream of the return channel,

a paint pump means operatively connected to the supply channel, the return channel and the first and second drop lines,

the first drop line including a first coil to limit changes to a first drop line flow rate in the first drop line to within a proportional change in a first flow controlling pressure differential in the first drop line between the supply channel and the return channel, and

the second drop line including a second coil, which is different than the first coil, to limit changes to the second drop line flow rate to within a proportional change in a second flow controlling pressure differential in the second drop line between the supply channel and the return channel.

18. - 20. (Cancelled)

21. (Cancelled)

22. (Previously Presented) A system as defined in claim 1, further comprising an output nozzle assembly in fluid communication with the coupling of each paint circulation line, the output nozzle assembly including one or more paint spray guns, flow meters, air operated pressure regulators, servo driven flow controllers and/or flushing systems.

23. (Previously Presented) A system as defined in claim 1, wherein the length of coiled tubing has one or more predetermined coil parameters, including inner tube diameter, coil diameter, coil length, and coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure.

24. (Previously Presented) A system as defined in claim 1, wherein one or more than one length of coiled tubing has an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

25. (Previously Presented) A system as defined in claim 1, wherein each length of coiled tubing is formed from stainless steel materials.

26. (Canceled)

27. (Previously Presented) A system as defined in claim 6, wherein a plurality of lengths of coiled tubing are arranged in series or in parallel in a corresponding paint circulation line, further comprising an output nozzle assembly attached to the coupling, the output nozzle assembly further comprising one or more paint spray guns, flow meters, air operated pressure regulators, servo driven flow controllers and flushing systems, the length of coiled tubing having one or more predetermined coil parameters, including inner tube diameter, coil diameter, coil length, and coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure, the length of coiled tubing having an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

28-29. (Canceled)

30. (Previously Presented) A system as defined in claim 8, wherein the length of coiled tubing has one or more predetermined coil parameters, including inner tube diameter, coil diameter, coil length, and coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure.

31. (Previously Presented) A system as defined in claim 8, wherein each length of coiled tubing has an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

32. (Previously Presented) A system as defined in claim 8, wherein each length of coiled tubing is formed from stainless steel materials.

33. (Canceled)

34. (Previously Presented) A system as defined in claim 9, wherein a plurality of the lengths of coiled tubing being formed from stainless steel materials and arranged in series or in parallel in a corresponding paint drop line, one or more than one length of coiled tubing having an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 0.5 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

35. (Previously Presented) A system as defined in claim 14, further comprising a paint output nozzle assembly coupled to each drop line, a plurality of the lengths of coiled tubing being arranged in series or in parallel in a corresponding paint drop line, the output nozzle assembly including one or more paint spray guns, flow meters, air operated pressure regulators, servo driven flow controllers and flushing systems, one or more than one length of coiled tubing having an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

36. (Previously Presented) A system as defined in claim 15, further comprising a paint output nozzle assembly coupled to each of the paint drop lines, a plurality of the lengths of coiled tubing being arranged in series or in parallel in a corresponding paint circulation line, the output nozzle assembly including one or more paint spray guns, flow meters, air operated pressure regulators,

servo driven flow controllers and flushing systems, the length of coiled tubing having one or more predetermined coil parameters, including inner tube diameter, coil diameter, coil length, and coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure, one or more than one length of coiled tubing having an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch, each length of coiled tubing is formed from stainless steel materials.

37. (Previously Presented) A system as defined in claim 16, further comprising a paint output nozzle assembly coupled to each of the drop lines, the lengths of coiled tubing being arranged in series or in parallel in a corresponding paint drop line, each length of coiled tubing having an inner tube diameter, coil diameter, a coil length, and a coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure, one or more than one of the lengths of coiled tubing having an inner tube diameter ranging from about 1/8 inch to about 1/2 inch, a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

38. (Previously Presented) A system as defined in claim 17, further comprising a paint output nozzle assembly coupled to each of the drop lines.

39. (Canceled)

40. (Previously Presented) A system as defined in claim 17, wherein each length of coiled tubing has an inner tube diameter, coil diameter, a coil length, and a coil pitch, one or more of which being selected according to a predetermined flow induced differential pressure.

41. (Previously Presented) A system as defined in claim 17, wherein one or more than one length of coiled tubing has an inner tube diameter ranging from about 1/8 inch to about 1/2 inch,

a wall thickness ranging from about 0.020 inch to about 0.065 inch, a coil diameter ranging from about 1/2 inch to about 12 inches and a coil pitch ranging from about 1/8 inch to about 1 inch.

42. (Previously Presented) A system as defined in claim 17, wherein each length of coiled tubing is formed from stainless steel materials.

43. (Canceled)